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Use Recommendations for 3M 60928 Cartridge/Filter

Introduction

The 3M 60928 is a NIOSH-approved combination organic vapor/acid gas chemical cartridge/P100 particulate filter. While NIOSH does not have a test procedure to certify air purifying filters against radioiodine or methyl bromide, this combination cartridge is recommended by 3M for use against radioiodine or methyl bromide at ambient concentrations up to 5 ppm and for not more than one shift. Because radioiodine and methyl bromide are poorly adsorbed on activated charcoal, the sorbent in this cartridge is impregnated with triethylenediamine (TEDA) and has an optimized porosity and particle size to maximize efficiency. The cartridge is approved in combination with several 3M half and full facepiece respirators.

General description: Use against radioiodine

The 60928 is specifically designed for use in environments containing radioactive isotopes of iodine. It differs from the 3M 60923 combination organic vapor/acid gas chemical cartridge/P100 particulate filter in that the carbon sorbent used in the 60928 was developed to effectively remove radioiodine species under conditions of high temperature and humidity. The P100 filter has greater than 99.97% filtration efficiency against a 0.3 micrometer (Mass Median Diameter) dioctyl phthalate (DOP) aerosol. The cartridge and filter are effective against particulate aerosols including radionuclides and radon daughters attached to particulate aerosols.

Background

Radioactive isotopes of iodine are found in irradiated nuclear fuel, are used as radioactive tracers to synthesize radiopharmaceuticals and in medical imaging. When concentrations exceed recommended exposure limits, they represent a potential health hazard to workers if present in respirable form in air. ^{131}I is of particular concern. Radioiodine species often become attached to small airborne particles. Therefore an air-purifying canister or cartridge used for airborne radioiodine requires a particulate filter as well as a chemical cartridge for vapor-phase radioiodine species.

One of the most penetrating vapor-phase radioiodine species through activated carbon filters at high humidity is methyl radioiodide. Work by Gerry O. Wood at Los Alamos (Ref 1) has shown that for TEDA impregnated carbons, penetration of non-radioactive CH_3I may be used as a direct measurement of the penetration of $CH_3{}^{131}I$. Although Wood's work was done with iodine-131, other iodine isotopes should behave similarly.

Wood's results showed that the reaction of methyl iodide with the TEDA impregnant follows first order kinetics, *i.e.,* removal efficiency of methyl iodide by TEDA is independent of methyl iodide concentration in the carbon bed. This is important because it allows the evaluation of air purifying canister/cartridge performance using ppm challenge levels of methyl iodide instead of the orders of magnitude lower concentrations of radioiodine found in nuclear environments.

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Testing Procedure

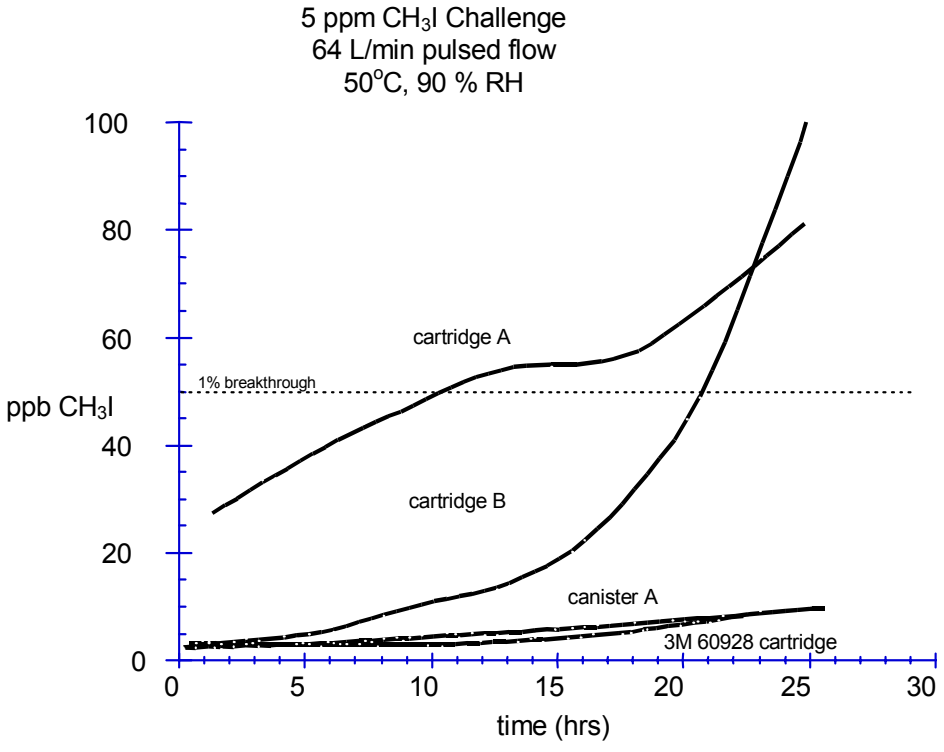
Neither NIOSH nor the NRC has an established test procedure by which air-purifying chemical cartridges and canisters are certified against radioiodine. High temperatures and high relative humidities are known to increase methyl iodide penetration of TEDA impregnated carbon filters (Ref 2). 3M chose to test methyl iodide penetration under very severe test conditions similar to those that might be encountered in an emergency situation. These conditions are shown in Table 1 below. Pulsed flow was used to simulate the high flow/no flow conditions which exist in actual cartridge use, since expiration air exits through an exhale valve rather than the filters.

Table 1

Test Parameter	3M Test
vapor	CH_3I
concentration	5 ppm
relative humidity	(90 ± 2)%
temperature	50°C (122°F)
flow	64 L/min pulsed flow [0.82 sec @ 192 L/min; 1.64 sec @ 0 L/min]
maximum penetration	1% instantaneous (50 ppb)
minimum service life	8 hours

Test results

The graph below shows typical methyl iodide penetration versus time for several cartridges and canisters under the test conditions of Table 1. Even though the sorbents used in all four air purifying elements have similar levels of TEDA impregnation, they perform quite differently. The 3M 60928 cartridge pair performs similarly to a competitive canister containing considerably more sorbent. This is because its base carbon was selected to maximize the efficiency of methyl iodide removal.



The sorbent used in the 60928 results in methyl iodide removal efficiency comparable to the much larger volume of conventional TEDA impregnated sorbent found in a canister. Ultimate capacity of the 60928 for methyl iodide is less than that of the canister, but in most nuclear applications this is not an important selection consideration, since daily change-out of cartridges is routine. The concentrations of methyl radioiodide encountered in a nuclear facility are typically many orders of magnitude less than the 5 ppm methyl iodide challenge used in respirator testing, and filters are typically discarded after being used for just one shift.

References

1. Am Ind. Hyg. Assoc. J. 42(8):570-578 (1981)

2. Am Ind. Hyg. Assoc. J. 46(5):251-256 (1985)

General description: Use against methyl bromide

Methyl bromide is a colorless, odorless gas at room conditions. It is widely used in the fumigation industry to treat fruit and vegetable fields by injecting it into the ground, covering the treated area with a plastic tarp, and letting the methyl bromide percolate up through the soil. This process kills insect pests in the soil and prepares the area for the next planting cycle.

In a like manner, pallets due for international shipment are also covered and subsequently treated to kill insect pests in either the pallet or the contents of the shipment. Buildings infested with pests are also treated in a similar manner.

Because of fact that methyl bromide is not captured well by typical organic vapor respirators, fumigation workers must use atmosphere supplying respirators, either airline or SCBA, if the concentration of methyl bromide exceeds 1 ppm. This leads to cumbersome equipment for the workers, or in the case of California regulations, limits the workers to a maximum work shift in the fields of three hours.

Testing Procedure

To verify the 3M 60928 cartridges were effective against methyl bromide, they were tested against the challenge indicated in Table 2 below. Single cartridges were tested in this example.

Table 2

Test Parameter	3M Test
vapor	CH_3Br
concentration	10 ppm
relative humidity	50 +/-2 %
temperature	23°C
flow	32 L/min steady flow
maximum penetration	1ppm (instantaneous)

Test results

The graph below show the time required for the concentration in the effluent to reach 1.0 ppm. As can be seen, at a challenge level of 10 ppm the cartridges lasted over 20 hours before reaching 1.0 ppm in the effluent. At the end of the test, the methyl bromide source was turned off (i.e. only clean air passed into the cartridge) and the effluent from cartridges returned to the baseline. This is significant in that it shows the methyl bromide has been captured and does not migrate through the carbon bed even after the challenge gas has been turned off.

Based on these test results, and to be conservative with regards to safety, 3M recommends that a properly fitted facepiece with a 60928 cartridge be used for a maximum of one shift, and in areas where the methyl bromide concentration does not exceed 5 ppm.